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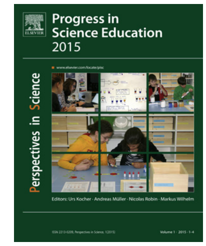

Darwinism in Context: An interdisciplinary, highly contextualized course on nature of science☆

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Summary In this article, we describe a course, titled *Darwinism in Context*, which focuses on the social, cultural and scientific influences on the development of Darwin's theory. This was an interdisciplinary, highly contextualized nature of science course that aimed to help students learn about a core nature of science aspect: that there are historical, cultural and social influences on the practice and directions of science. For this purpose, the course was based on a well-documented historical case study: the development of Darwin's theory. The course consisted of five classes that focused on: (a) Victorian society, (b) the views and beliefs of scholars that had an impact on Darwin's thinking (historical influences), (c) aspects of Darwin's personal and social life that influenced the publication of his theory (social influences), (d) the reception of Darwin's theory and the relationship between religion and science (cultural influences) and (e) the relationship between science and literature. In all cases, teaching included presentations of the historical events but was mostly based on the analysis and discussion of excerpts from the respective original writings. During the classes only a few examples were presented; students were motivated to study further the original writings and identify some key concepts and ideas after the classes. It is concluded that this kind of highly contextualized nature of science instruction can provide students with a more authentic view of science.

Introduction

In contemporary science education literature it is widely accepted that students should be taught about nature of science (hereafter NOS): how scientific knowledge is produced and what its characteristics are. Students often hold preconceptions about these (Lederman, 1992; McComas et al.,

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1998), which form the basis for an incorrect perception of what science can achieve. Therefore, teaching about NOS involves a process of conceptual change from initial preconceptions (see Clough, 2006), such as that science gives definitive answers or that scientists are always objective, to more informed views that counter these preconceptions and help debunk the relevant myths about science (see McComas et al., 1998; Numbers and Kampourakis, 2015). In order to achieve this, it is important to develop appropriate NOS courses that challenge students' preconceptions and provide them with a more authentic portrayal of how science is done. Research also suggests that NOS teaching is effective when it is explicit and reflective (Bell et al., 1998; Khishfe and Abd-El-Khalick, 2002).

In general, explicit/reflective NOS instruction can take three forms: (a) Decontextualized, (b) Moderately contextualized and (c) Highly contextualized NOS instruction. The latter is based on the presentation of historical and contemporary cases, explicitly connected to topics taught in particular science subjects (Clough, 2006). This can be achieved by using historical short stories in order to teach science content and draw students' attention to NOS. Such stories have been created for post-secondary introductory astronomy, biology, chemistry, geology, and physics courses (Clough, 2011). It has also been found that, despite institutional constraints, teachers can effectively teach about NOS alongside science content when they have the appropriate training (Clough and Olson, 2012). A first step to introducing students to NOS could be by emphasizing some NOS aspects during regular science instruction. Teachers might refer to historical figures, often mentioned in textbooks anyway, and refer to the details of their life and work in order to discuss some NOS aspects and challenge students' preconceptions about these (see McComas and Kampourakis, 2015, for more examples from the history of biology, chemistry, geology and physics). However, if there is available time one can go even further and develop specialized courses about NOS.

Several studies have drawn on the history of evolutionary thought in order to develop teaching sequences aiming at helping students understand evolutionary concepts or nature of science. For instance, Jensen and Finley (1997) drew on history of science to present to undergraduate students the views of Georges Cuvier, Jean Lamarck, William Paley and Charles Darwin. Students were involved in a series of instructional activities that included use of historical vignettes to introduce the historical figures and their views, as well as students' engagement in problem solving. A similar approach, developed for high school, presented simultaneously the views of Charles Darwin, Jean Lamarck, and William Paley. Students were asked to compare these and assess the explanatory power of each, by using them to explain phenomena other than those described in the original writings (Passmore and Stewart, 2002). Whereas the involvement of students in problem-solving and inquiry activities of this kind certainly has a pedagogical value, it should be made explicit to students that Paley and Lamarck did not develop evolutionary theories in the way Darwin did, as well as that their writings long preceded Darwin's and actually had an influence on him (Kampourakis and McComas, 2010).

This is why it is very important to obtain historical information form the original writings (see e.g. Largent, 2004), as far as this is possible, or from books written by professional historians of science. If this is not the case, several ''myth conceptions'' may arise and alter the view that students (and teachers) may have for the actual course of events in the historical development of evolutionary theory. For instance, such ''myth-conceptions'' are that Darwin was the official naturalist of the Beagle, that he discovered natural selection while on the voyage of the Beagle, or that he even was the only one who came up with the idea of evolution by natural selection (McComas, 1997). In the cases of Paley and Lamarck discussed above, a careful and detailed study of history shows that presenting their views as alternative to Darwin's is problematic. On one hand, Paley's argument was a theological one as he tried to explain God through nature and not nature through God (Shapiro, 2015). On the other hand, Darwin did not reject the so-called ''Lamarckian'' mechanisms of use and disuse and of the inheritance of acquired characters, and was perhaps more ''Lamarckian'' than Lamarck himself in this respect (Burkhardt, 2015).

It is therefore crucial to draw on history and give an authentic portrayal of the development of evolutionary thought to students. For instance, what we often call ''the evidence for evolution'' (fossils, biodiversity, geographical distribution, comparative anatomy) are not just elements that support Darwin's theory, which were collected after the latter was conceived. On the contrary, these were related to questions naturalists of that time asked, to which Darwin's theory eventually provided satisfactory, natural explanations (Farber, 2003). Therefore, by presenting the development of science in its historical, social, cultural contexts, we can provide students with a more authentic view of nature of science. It is in this spirit in which the course presented here was developed. *Darwinism in Context* is an interdisciplinary course that focused on the interaction between science and society: how historical, social and cultures influences affected Charles Darwin's science and then how science influenced other aspects of culture such as literature. The novelty in this course is that an English literature teacher and a Biology teacher taught classes together, both continuously emphasizing the interaction between science and society. The rationale for this kind of highly contextualized NOS instruction, based on analyses of original writings, has been described elsewhere (Kampourakis and McComas, 2010).

Structure of the course

The writings of Copernicus, Kepler, Galileo, Newton among others in the sixteenth and seventeenth centuries brought natural phenomena into the realm of science, showing that they could be rationally explained. Thus, it was found that the earth was a small planet among others rotating around the sun, as well as that the motions of the planets could be explained by the same simple laws that accounted for the motion of physical objects on earth. This was a revolutionary conceptual shift that changed our conception of the universe. Until the mid-19th century the origin of the marvellous adaptations of organisms were either left unexplained or were attributed to design. The publication in 1859 of *The Origin of Species* (hereafter *Origin*) by Charles Darwin (1809—1882) provided another revolutionary conceptual